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Effect of Postharvest Treatments of Calcium Chloride and Gibbrellic Acid on Storage Behaviour and Quality of Guava Fruits

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Abstract: Guava fruits of cultivar 'Allahabad Safeda' were harvested at green mature stage. The fruits were given postharvest treatments of calcium chloride (1, 2, 3%), gibbrellic acid (25, 50, 75 ppm) each for 5 minutes. The fruits were air dried and packed in corrugated fibre board boxes and stored in walk-in cold-room maintained at 6 ± 1°C and 90-95% RH. A control (lot of fruits without any treatment) was also stored under same conditions. The fruits were analysed for various quality attributes at different storage interval periods for four weeks. The data revealed that postharvest application of Calcium chloride (2%) resulted in extending the storage life of guava fruits upto 4 weeks with minimum weight loss, desirable firmness and highly acceptable quality.

Key words: Guava · Calcium chloride · Gibbrellic acid · Storage · Quality

INTRODUCTION

Guava is believed to be introduced in India since early 17th century. In India, it is 5th most widely grown fruit, occupying an area of 2.2 lakh ha, with annual production of 22.70 lakh MT [1]. 'Allahabad Safeda' is an important cultivar of guava, which is known for its excellent size, appearance and pleasant flavour. Guava is a climacteric fruit [2], ripens rapidly after harvest and therefore hasshort shelf life. It is highly perishable fruit and loses its texture and quality in 3-4 days at ambient temperature. Therefore, guava fruits are required to be managed appropriately in order to get a regulated market supply through judicious use of post-harvest treatments followed by storage at appropriate temperature and relative humidity. The role of calcium in the physiology of plant tissue is well established [3]. It contributes to improve therigidity of cell walls and retard tissue softening and delay ripening [4]. Similarly application of gibbrellic acid has been reported to delay senescence in fruits [5]. Keeping these view points in forefront, the study was conducted with objectives to find out the suitable post-harvest treatment for improving the storage life and quality of guava fruits cv. Allahabad Safeda.

MATERIALS AND METHODS

Materials: The uniform medium sized fruits apparently free from diseases and bruises were harvested at physiological mature stage and divided into requisite lots for further handling.

Methods

Postharvest Treatments, Packaging and Storage: The fruits were dip treated with aqueous solution of different concentrations of calcium chloride (1%, 2% and 3%) and gibbrellic acid (25 ppm, 50 ppm and 75 ppm) separately each for five minutes. The control fruits were dipped in tap water for five minutes and kept for comparison. The surface of fruits was air dried and thereafter packed in corrugated fibre board boxes. The fruits were stored in walk-in cold-room maintained at 6 ± 1°C and 90-95% RH.

Analytical Methods: The physiological loss in weight (PLW) of fruit was calculated on initial weight basis and expressed in percent. The fruit firmness was measured with the help of a penetrometer (Model FT- 327, USA) using 8 mm stainless steel probe and expressed in terms of pound force pressure (lb force). The overall organoleptic rating of the fruits was done by a panel of ten judges on the basis of 9-point Hedonic scale [6]. The total soluble solids (TSS) of the fruit juice were determined using a hand refractometer and expressed as percent TSS after making the temperature correction at 20°C. The total sugars, titratable acidity and ascorbic acid content of fruits were estimated per standard procedure [7].

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Statistical Analysis: There were three replications for each treatment and each replicate was comprised of 20 fruits. The experiment was laid out in completely randomized design [8].

RESULTS AND DISCUSSION

Physiological Loss in Weight (PLW): The percent PLW, in general, increased with the advancement in storage period rather slowly in the beginning but at a faster place as the storage period advanced (Table 1). The lowest mean PLW (1.98%) was observed in fruits treated with calcium chloride (2%) closely followed by calcium chloride (3%). On the other hand, the highest mean PLW (3.32%) was observed in control fruits. During different storage interval periods, $CaCl_2$ (2%) treated fruits showed lowest weight loss, which ranged between. 0.66 to 2.66% from 7 days to 28 days of cold storage, respectively as compared to control where PLW ranged between 0.96 to 5.16 percent during the same intervals. Calcium application has been reported to be effective in terms of membrane functionality and integrity maintenance with lower losses of phospholipids and proteins and reduced ion leakage which could be responsible for the lower weight loss in plums [9]. Favourable affects of $CaCl_2$ in reducing the PLW has been reported in mango [10].

Firmness: The fruit firmness, in general followed a declining trend commensurate with advancement in storage period (Table 1). The fruits treated with calcium chloride maintained higher firmness as compared to GA_3 and control at all storage intervals. Calcium chloride (2%) treated fruits demonstrated the best effect on maintaining fruit firmness and registered maximum mean fruit firmness (14.55 lb force) as compared to control fruits (9.97 lb force). The fruit treated with calcium chloride (2%) maintained higher fruit firmness throughout the stipulated storage period of 4 weeks which ranged between 17.40 lb force to 11.10 lb force as compared to the other treatments. On the other hand, the control fruits experienced the faster loss of firmness during storage and ranged between 15.30 lb force to 5.50 lb force, thereby leading to excessive softening and shrivelling of fruits. Softening of fruits is caused either by breakdown of insoluble protopectins into soluble pectin or by hydrolysis of starch [11]. The desired effect of calcium on maintaining fruit firmness may be due to the calcium binding to free carboxyl groups of polygalacturonate polymer, stabilizing and strengthening the cell wall [12]. The maintenance of higher firmness as a result of calcium chloride may be due to their ability to prevent the physiological weight loss during storage and to inhibit/delay ethylene production and/or action in different fruits [13].

Spoilage Percentage: The different post-harvest treatments showed wide variation in spoilage percentage during cold storage (Table 2). There was no spoilage of fruits till 7 days of storage in any treatment including control. The lowest mean cumulative spoilage (2.12%) was recorded in fruits treated with calcium chloride (2%) followed by fruits treated with Calcium chloride (3%). However, the cumulative spoilage remained at higher levels (16.92%) in control fruits as compared to the other treatments. In control fruits the level of spoilage increased from 2nd week of storage (15.14%) to 4th week of storage (30.41%) followed by gibbrellic acid treatments. However, the level of spoilage was considerably low with calcium chloride treatments. In general, the spoilage of fruits was decreased with increase in concentration of calcium chloride. The current study demonstrates that application of calcium chloride has merit in reducing spoilage in guava fruits which may be due to their positive role in delaying the senescence of fruits by maintaining cell wall integrity and thus lowering the spoilage. Beneficial effects of calcium against postharvest decay have been shown for various fruit species [14].

Sensory Quality: The mean sensory quality score was significantly the highest (7.11 out of 9) in fruits treated with calcium chloride (2%) which was closely followed in calcium chloride 3% (Table 2). The control fruits recorded the lowest score (5.94 out of 9). Initially, the fruits treated with calcium chloride were rated as slightly desirable on 7th day, thereafter, the organoleptic quality, gradually increased upto 3 weeks and fruits were rated as very much desirable to moderately desirable. The fruits remained in moderately desirable conditions upto 28 days of storage in calcium chloride (2 and 3%) treatments as compared to gibbrellic acid and control treatments. However, in control the fruits maintained best organoleptic score (7.95 out of 9) after 14 days of storage and were rated as much desirable and thereafter a sharp decline in organoleptic score was noticed in control resulting in fair to poor acceptability of fruits. Calcium application has been reported to improve the organoleptic quality of mango [15].

Total Soluble Solids (TSS) and Total Sugars: The data revealed that in calcium chloride treatments the TSS and total sugars content of guava fruits increased slowly and steadily upto 3 weeks of storage and thereafter declined gradually (Table 3). On the other hand, in case of control and gibbrellic acid treatments the TSS and total sugars

Table 1: Effect of $CaCl_2$ and GA_3 on the physiological loss in weight (PLW) and firmness of guava fruits during storage

	PLW (%)					Firmness (lb force)				
Treatment	7	14	21	28	Mean	7	14	21	28	Mean
$CaCl_2$ 1%	0.83	1.66	2.83	3.45	2.19	17.10	16.10	13.10	10.20	14.12
$CaCl_2$ 2%	0.66	2.11	2.50	2.66	1.98	17.40	16.20	13.50	11.10	14.55
$CaCl_2$ 3%	0.83	1.83	2.66	2.87	2.04	17.84	16.80	13.60	10.50	14.68
GA_3-25 ppm	0.83	2.22	2.83	3.44	2.33	16.10	12.10	8.40	6.70	10.82
GA_3-50 ppm	0.66	2.33	2.41	3.54	2.24	16.20	13.10	10.50	7.80	11.90
GA_3-75 ppm	0.66	2.50	3.16	3.66	2.49	16.30	12.10	9.50	6.40	11.07
Control	0.96	2.33	4.83	5.16	3.32	15.30	11.30	7.80	5.50	9.97
Mean	0.78	2.14	3.03	3.54		16.61	13.96	10.91	8.31	
C.D.(0.05)	Treatments = 0.10					0.22				
	Storage = 0.40					0.70				
	Interaction = 0.56					1.26				

Table 2: Effect of $CaCl_2$ and GA_3 on the physiological loss in weight (PLW) and firmness of guava fruits during storage

	Spoilage (%)					Sensory quality				
Treatment	7	14	21	28	Mean	7	14	21	28	Mean
$CaCl_2$ 1%	0.00	7.06	9.10	10.45	6.65	6.13	7.51	7.62	6.24	6.88
$CaCl_2$ 2%	0.00	4.16	7.40	8.71	5.07	6.25	7.56	7.86	6.80	7.11
$CaCl_2$ 3%	0.00	4.16	7.50	8.89	5.14	6.33	7.52	7.73	6.90	7.12
GA_3-25 ppm	0.00	9.01	12.71	18.30	10.00	7.39	7.86	5.53	5.17	6.48
GA_3-50 ppm	0.00	8.33	10.83	19.11	9.57	7.66	7.40	7.32	5.43	6.95
GA_3-75 ppm	0.00	3.71	8.33	18.14	7.54	7.71	7.63	7.50	5.93	7.19
Control	0.00	15.14	22.14	30.41	16.92	7.60	7.95	5.06	3.14	5.94
Mean	0.00	7.37	11.14	16.29		7.01	7.63	6.95	5.66	
C.D. (0.05)	Treatments = 0.12					0.18				
	Storage = 0.49					0.39				
	Interaction = 0.76					0.60				

Table 3: Effect of $CaCl_2$ and GA_3 on TSS and total sugars of guava fruits during storage

	TSS (%)					Total sugars (%)				
Treatment	7	14	21	28	Mean	7	14	21	28	Mean
$CaCl_2$ 1%	9.14	9.17	10.01	9.89	9.55	5.63	5.91	5.86	5.71	5.78
$CaCl_2$ 2%	9.36	10.13	10.45	10.01	9.99	5.60	5.85	6.93	6.22	6.15
$CaCl_2$ 3%	9.46	9.91	10.66	9.43	9.87	5.66	5.70	6.90	6.30	6.14
GA_3-25 ppm	9.21	10.11	9.11	9.01	9.36	5.40	5.90	5.60	5.45	5.59
GA_3-50 ppm	10.11	11.12	9.11	8.72	9.77	5.40	5.92	5.70	5.50	5.63
GA_3-75 ppm	9.47	10.11	9.55	9.11	9.56	5.46	6.00	5.72	5.60	5.70
Control	10.00	11.05	8.45	7.51	9.25	5.72	6.20	5.20	4.80	5.48
Mean	9.54	10.23	9.62	9.10		5.55	5.93	5.99	5.65	
C.D.(0.05)	Treatments = 0.15					0.09				
	Storage = 0.26					0.16				
	Interaction = 0.52					0.32				

Table 4: Effect of $CaCl_2$ and GA_3 on titratable acidity and ascorbic acid content of guava fruits during storage

	Acidity (%)					Ascorbic acid (mg/100g)				
Treatment	7	14	21	28	Mean	7	14	21	28	Mean
$CaCl_2$ 1%	0.39	0.36	0.33	0.31	0.35	140.10	129.40	121.12	119.14	127.44
$CaCl_2$ 2%	0.41	0.39	0.38	0.36	0.39	142.10	130.20	122.14	119.55	128.50
$CaCl_2$ 3%	0.42	0.40	0.32	0.31	0.36	143.10	128.40	121.14	118.14	127.69
GA_3-25 ppm	0.39	0.32	0.26	0.21	0.30	135.10	124.10	117.14	109.14	121.37
GA_3-50 ppm	0.41	0.37	0.30	0.22	0.33	136.10	127.10	119.15	110.13	123.12
GA_3-75 ppm	0.39	0.35	0.28	0.20	0.31	136.90	126.10	118.13	110.12	122.81
Control	0.36	0.24	0.23	0.20	0.26	126.43	123.30	115.12	106.14	117.75
Mean	0.40	0.35	0.30	0.26		137.12	126.94	119.13	113.19	
C.D.(0.05)	Treatments = 0.04					0.50				
	Storage = 0.07					0.68				
	Interaction = 0.15					0.92				

content increased upto 2 weeks and thereafter sharp decline was noticed indicating rapid metabolic breakdown in these fruits. The fruits treated with $CaCl_2$ at 2% registered maximum average TSS content (9.99%) and total sugars (6.15%) and this treatment was significantly better as compared to other treatments. However, the second best treatment was found to be calcium chloride (3%). The control fruits recorded the lowest average TSS content (9.25%) and total sugars (5.48%). The increase in TSS and sugars during storage may possibly be due to hydrolysis of starch into sugars as on complete hydrolysis of starch no further increase occurs and subsequently a decline in these parameters is predictable as they along with other organic acids are primary substrate for respiration [16]. In calcium chloride treated fruits, the increase in TSS and total sugars upto 21 days and gradual declined thereafter as compared to gibbrellic acid and control fruits where increase in TSS and total sugars was noticed upto 14 days and sharp decline thereafter, indicating the possible role of calcium in delaying metabolic activity of fruits during storage [17].

Titratable Acidity: The acidity of guava fruits experienced a linear decline during storage period (Table 4). However, the loss of acidity during storage was more rapid and faster in control and gibbrellic acid treated fruits, whereas it was gradual in case of calcium chloride treated fruits. The lowest mean acid content (0.26%) was noticed in control, whereas the highest mean acid content (0.39%) was observed in the fruits treated with calcium chloride (2%) and these treatments were at par with calcium chloride (1 and 3%). The decrease in titratable acids during ripening and storage may be attributed to an increase in malic enzyme and pyruvate decarboxylation reaction during the climacteric period [18]. The fruits treated with Calcium chloride maintained higher acidity during storage probably due to delay in ripening process [19].

Ascorbic Acid: The ascorbic acid content of fruits decreased with the advancement of storage period (Table4). The ascorbic acid content in different treatments varied significantly at all storage intervals. The highest mean ascorbic acid content 128.50 mg/100 g was recorded in fruits treated with calcium chloride (2%) and the lowest (117.75 g/100 g) in control fruits. However, in calcium chloride treatments a slower and steadier loss of ascorbic acid content was noticed. Calcium treated apple retained higher ascorbic acid as compared to control [20].

It could be concluded that freshly harvest green mature guava fruits treated with calcium carbide (2%) can be stored at 6 ± 1°C and 90-95% RH for four weeks with acceptable quality

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